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Energy consumption by forestry and agric
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ENERGY CONSUMPTION BY FORESTRY AND AGRICULTURE IN MONTANA

Prepared By

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MONTANA ENERGY ADVISORY COUNCIL
Staff Paper 76-3

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Energy Consumption by Forestry and Agriculture in Montana

Various estimates of fuels consumption in the forestry and agricultural sectors in Montana were gathered and reviewed to obtain order-of-magnitude estimates of energy use in these areas. The data at this time are very approximate and show little or no breakdown by process or function.

A brief summary of energy consumption estimates by fuel type is presented in Table 1. In general, natural gas and electricity use data in the forestry sector can be considered firm data, whereas petroleum products use in either sector is very crude. Use of natural gas and electricity for agricultural purposes other than irrigation, and for all use of LPG in agriculture are not included in Table 1.

Table 1
Approximate Annual Consumption of Selected Fuels by the Forestry and Agriculture Sectors in Montana

Sector	(1) 1/ Natural Gas (MMCF)	(2) 1/ Electricity (million KWH)	(3) 2/ Gasoline (million gallons)	(4) 2/ Diesel Fuel (million gallons)	Total of (1)-(4) (10^{12} BTU)
Forestry	5,600	390.0	0.9-2.0	4.6-7.9	7.7-8.3
Agriculture	6.6 3/	.18 3/	30.0-40.0	25.0-35.0	7.25-10.0

1/ Data are for 1974.
2/ Data are for 1973.
3/ Data shown include only energy used for irrigation.

Forest Sector

Two estimates were used for gasoline and diesel fuel consumption in timber harvesting and hauling to the first level of processing. First, a study of forestry energy use in Washington state by N. K. Whittlesey (1) was reviewed. Estimates derived in the Washington state study are shown in Table 2; more detailed data from this study are presented in the attachments. Secondly, similar estimates were prepared by Plum Creek Lumber Company for the Montana Fuel Allocation Office (FAO) in 1974. These are also shown in Table 2.

Table 2
Estimates of Fuel Use for Timber Harvesting and Hauling
(gallons/1000 board feet)

Fuel -- Estimate	Logging	Hauling	Total
Gasoline -- Whittlesey	.774	.521	1.295
FAO	--	--	2.857*/
Diesel Fuel -- Whittlesey	2.512	4.178	6.690
FAO	--	--	11.429*/

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*/ Estimate originally calculated as one million gallons per 70 million board feet, with 80 percent to diesel fuel and 20 percent to gasoline.

Using these estimates of fuel consumption per unit with the 1973 Montana harvest of 691 million board feet, gives estimates of total fuels used, as shown in Table 3.

Table 3
Estimates of Fuels Used for Timber Harvesting and Hauling in Montana in 1973

		Estimates of Fuels Consumed (1000 gallons)			
		Whittlesey		FAO	
Activity	1973 Harvest	Gasoline	Diesel Fuel	Gasoline	Diesel Fuel
Logging	691 x 10^6 bf	535	1,736	--	--
Hauling	691 x 10^6 bf	360	2,887	--	--
Total		895	4,623	1,974	7,897

Fuels used in the lumber and paper industries in Montana consist mainly of (1) purchased and self-generated electricity, (2) purchased natural gas, and (3) wood and process residues. Some use of residual fuel oil exists, but it is relatively small compared to the other energy inputs. Data for total use of purchased electricity and purchased natural gas is quite good, and is presented in Table 4, by standard industrial classification (SIC).

Table 4
Forestry Sector Consumption of Natural Gas and Purchased Electricity in Montana in 1974 3/

SIC Code	Electricity 1/ (1000 KWH)	Natural Gas (1000 MCF)	2/Percent of Mt. Industrial Sales Elec.	2/Percent of Mt. Industrial Sales Gas	Percent of Mt. Total Sales Elec.	Percent of Mt. Total Sales Gas
24 Lumber and Wood Products	235,176	900	4.0%	2.4%	2.5%	1.1%
26 Paper and Allied Products	151,047	4,700	2.5%	12.5%	1.5%	5.8%
Total SIC 24 and 26	386,223	5,600	6.5%	14.9%	4.0%	6.9%

1/ Source: Federal Reserve Bank of Minneapolis. (2)
2/ Source: Gas Requirements Committee of the University of Denver Research Institute. (3)
3/ Forestry manufacturing only.

Complete data is not available for total use of hog fuel as an energy source in Montana forest products industries, however; some examples are presented in Table 5.

Table 5
Examples of Use of Wood and Process Residues
as Energy Sources by Lumber and Paper Industries
in Montana in 1974 [1]

Company	Fuel	Approximate Use in 1974	Percent of Total Energy Inputs
Hoerner-Waldorf Corporation	Hog Fuel	110,000 tons	9%
	Black Liquor (oven dried)	57,500 tons	57%
Plum Creek Lumber Company	Wood Shavings and Sawdust	54,750 tons [2]	--
	Bark	16,800-27,600 tons [3]	--
St. Regis	Hog Fuel	370,000 tons	99%

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[1] Source: Solid Waste Management Bureau, Department of Health and Environmental Sciences. (4)
[2] Reported in the source document as 150 tons/day average.
[3] Reported in the source document as 1,400-2,300 tons/month average.

Agriculture

Due to the decentralized and diverse use of energy within the agricultural sector, data for fuels consumption in Montana is not well developed. Estimates for fuels used for irrigation in Montana in 1974 have been developed by Gordon Sloggett, USDA, ERS, at Oklahoma State University. (5) These estimates are shown in Table 6.

Table 6
Acres Irrigated and Energy Consumed for Irrigation in Montana in 1974, by Type of Fuel

Fuel Type	Units	Acres Irrigated by Pumping	Total Energy Use (physical units)	Energy Use Per Acre (phy. units)	Energy Use Per Acre (million BTU/acre)
Electricity	1000 KWH	270,510	178,423	.660	2.252
Diesel	gallons	36,930	2,104,200	56.978	7.909
Gasoline	gallons	13,740	1,203,180	87.568	10.946
Natural Gas	MCF	400	6,610	16.525	16.525
LPG	gallons	3,250	281,200	86.523	8.263
Total		324,030	--	--	3.349

Various estimates of the volume of gasoline and diesel fuel consumed by agriculture for field operations are presented in Table 7 (further documentation of these estimates is contained in the attachments). Operations included within the various estimates are not clearly defined, hence the estimates may not be directly comparable.

Table 7
Estimates of Montana Agricultural Use of Gasoline and Diesel Fuel for Major Crops in 1973 (1000 gallons)

Source of Estimate	Gasoline	Diesel Fuel	Total
Montana State University[1]	43,213	22,815	66,028
Montana State University[2]	46,998	43,358	90,356
Iowa State University[3]	39,156	26,104	65,260
Federal Energy Administration[4]	24,000	22,333	46,333
Montana Department of Revenue 5/	29,875	--	--
Montana State University[6]	26,544	--	--

1/ Taken from (6), data shown exclude energy use for "summer fallow". (See attachments).

2/ Taken from (6), data shown include energy use for "summer fallow". (See attachments).

3/ Per acre energy use estimates taken from (7), applied to 1973 Montana agricultural data. (See attachments).

4/ Taken from (8).

5/ Taken from (9). (See attachments).

6/ Taken from (10). (See attachments).

REFERENCES

(1) Norman K. Whittlesey, Energy Use in Forest Products Industries in Washington, Washington Agricultural Experiment Station, Circular 573, June 1974.

(2) Federal Reserve Bank of Minneapolis, Ninth Federal Reserve District Electric Energy Consumption, monthly.

(3) Gas Requirements Committee, University of Denver Research Institute, Future Gas Consumption of the United States, Volume 6, December 1975.

(4) Energy and Secondary Materials Market Final Report, prepared for the Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences, May 1976.

(5) Gorden Sloggett, Energy Used for Pumping Irrigation Water in the U. S., 1974, discussion draft, February 1976.

(6) B. Davis, G. Hokanson, and H. Whitaker, Energy Requirements for Crop Production in Montana, Agricultural Economics and Economics Department, Montana State University, Staff Paper 75-11, April 1975.

(7) Dale Hull and H. J. Hirning, "Estimating Farm Fuel Requirements for Crop Production and Livestock Operations", Iowa State Weekly Weather and Crop Bulletin, June 4, 1974.

(8) Federal Energy Administration, Son-of-Strawman Data Series, May 15, 1976.

(9) John Clark, Research Division, Montana Department of Revenue, personal communication, May 1976.

(10) John Braunbeck, Montana Fuel Allocation Office, memorandum concerning information supplied by Dick Meyer, Montana Department of Agriculture, February 27, 1975.

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APPENDIX

Attachment 1
from: Energy Use in Forest
Products Industries in
Washington, by Norman Whittlesey

Table 4. Energy use per unit of output in forestry products

Activity	Unit	Steam or energy equiv. lb/unit[a,c]	Electricity kwh/unit[a]	Gasoline gal/unit[b]	Diesel gal/unit[b]
Logging	10^3bf			.794	2.512
Hauling logs	10^3bf			.521	4.178
Shakes	Sq	89	10.1		
Chipboard	sf-3/4"	2.7	.30		
Plywood	sf-3/8"	3.5	.18		
Veneer	sf	3.4	.29		
Lumber sawing[d]	bf	2.5	.25		
Lumber sawing[e]	bf	4.0	.30		
Lumber drying	bf	2.2			
Pulp unbleached (undried)	bdt	8,000	140		
Pulp bleached (undried)	bdt	10,000	400		
Pulp drying	bdt	5,000	175		
Chipping	bdt	13,000	500		
Paper (average)	wt	6,000	450		
Gypsum board	bdt	5,000	100		
Liner board	bdt	17,000	500		
Fine paper	bdt	26,000	900		
Misc. (toilet, blotting)	bdt	19,000	900		
Roof felt	bdt	1,000	100		
Newsprint	bdt	14,000	1500		
Converted paper-mill stock	bdt	14,000	200		

[a] Source: Dr. Ashley Emery, professor of mechanical engineering, University of Washington.

[b] Fuel requirements for logging and hauling were derived from a survey of loggers and haulers conducted by Matt Anderson, Washington Forest Protective Association.

[c] One pound of steam = 1,350 BTU consumed, average over all fuels.

[d] Class A and B mill sizes. See table 7 for definition of mill size.

[e] Class C and D mill sizes. See table 7 for definition of mill size.

Attachment 2, page 1 of 2
from: Energy Requirements for
Crop Production in Montana,
by Bruce Davis, et.al.

TABLE 1

Total Energy Requirements for Major Crops in Montana (1973)

Crop	Diesel Fuel	Gasoline	Total Energy
	(thousands of gallons)		(millions of BTU)
Alfalfa (I)	3,597	6,382	1,294,948
Alfalfa	1,012	837	245,468
Barley (I)	1,186	937	282,228
Barley	2,657	8,158	1,383,572
Dry Beans (I)	48	118	29,264
Corn, Silage (I)	1,197	489	228.216
Hay (I)	2,124	2,877	654,108
Hay	2,530	2,249	633,076
Oats (I)	151	355	65,160
Oats	492	1,471	251,284
Pasture (I)	276	556	457,584
Spring Wheat (I)	205	369	74,456
Spring Wheat	3,219	8,552	1,511,108
Sugar Beets (I)	925	1,006	254,244
Winter Wheat (I)	129	153	37,032
Winter Wheat	3,067	8.704	1,508,676
SUBTOTAL	22,815	43,213	8,552,512
Summer Fallow	20,543	3,785	3,345,360
TOTAL	43,358	46,998	11,897,872

The symbol "I" indicates irrigated production.

TABLE 2

Energy Requirements Per Acre for Major Crops in Montana (1973)

Crop	Diesel Fuel	Gasoline	Total Energy
	(Gallons per acre)		(thousands of BTU)
Alfalfa (I)	5.7	10.1	2050.4
Alfalfa	1.9	1.6	464.4
Barley (I)	9.4	7.4	2233.6
Barley	1.4	4.4	741.6
Dry Beans (I)	5.0	13.1	2324.4
Corn, Silage (I)	18.5	7.6	3532.4
Hay (I)	4.0	5.4	1219.6
Hay	3.6	3.2	900.8
Oats (I)	4.3	10.0	726
Oats	2.1	6.3	1075.2
Pasture (I)	1.1	2.1	414.4
Spring Wheat (I)	5.8	10.5	2114
Spring Wheat	1.7	4.4	783.6
Sugar Beets (I)	20.7	22.6	5700.4
Winter Wheat (I)	6.1	7.3	1759.2
Winter Wheat	1.5	4.2	730.8
Summer Fallow	4.4	.9	731.2

The symbol "I" indicates irrigated production.

Attachment 3, page 1 of 4
prepared by M.O. Mortensen,
MEAC staff

EXPLANATION COVERING TOTAL FUELS USED
IN
MONTANA AGRICULTURAL PRODUCTION IN 1973

Methods to compile the following information are explained below; not all information pertinent to the crop types is available in our office at this time. This makes it necessary to estimate in some cases.

Fuel use, gallons per acre are treated in the following manner--some general information includes:

L. P. gas was not included due to limited use for farm production.

Iowa State University Weekly Weather and Crop Bulletin of June 4, 1974, was used to estimate farm fuel requirements for crop production and livestock operations.

Montana Crop & Livestock Reporting Service Bulletin, of March 19th, 1974, was used for 1973 acres planted for all crops.

Montana Agricultural Statistics, Volume #14, 1970 and 1971 was used for the livestock census used in report.

Diesel powered tractors and equipment consume approximately 27% less fuel than gasoline power, (Information Source: 1973 Agricultural Engineers Yearbook), to preform the same work.

Inquiry was made in state concerning the split of diesel -vs- gasoline ratio. The conclusions are dependent in the area questioned. The areas that are primarily cattle and hay operations are heavy users of gas rather than diesel. The areas that are primarily dryland wheat operations are primary users of diesel, due to the progression to large diesel powered tractors and combines.

The Billings area seems to meet a balance of irrigated, dryland and cattle operations. The polling in this area ran near a 60% gasoline and 40% diesel split in total usage. I feel that the 60-40 ratio is probably close to the average for purposes of comparison. I have shown the 50-50 split also.

Sugarbeet planting and harvesting was not covered by the fuel bulletin. Due to my experience with beet production and corn silage production, it was determined that the corn silage type of crop covered by the bulletin would closely meet the demands of beet crops.

Dry bean crop was treated in the same category as soybeans.

Hay--native or grain type, which of course are cut only once per season; but yield more tonnage per cut, were included with the three cutting hay's that are in a category of being bailed. Haylage with three cuttings chopped, consume one-third more fuel to harvest! The amount of haylage harvested could probably off-set the difference of one cutting native or grain hay -vs- three cutting bailed hay fuel needs. Fuel needs for the one cut hay are not much less than three cut hay,due to greater yield of tonnage per cut.

Livestock Industry fuel needs were not asked for in the request; but due to the bulletin providing data, it is included, Certainly subject to disapproval or arguement, I have taken the ratio of 75% gas and 25% diesel as the split for livestock productions. It seems that this operation would consume much more gasoline than diesel.

ESTIMATE OF FUEL BURNED FOR CROP AND LIVESTOCK PRODUCTION UNDER AVERAGE CONDITIONS

8/74 - M. O. Mortensen

LIVESTOCK		FUEL USED PER UNIT		Montana TOTAL FUEL USED	
		GASOLINE (GALLONS)	DIESEL (GALLONS)	GASOLINE (GALLONS)	DIESEL (GALLONS)
Sheep - 1972	950,000	.60 P.U.	.45 P.U.	570,000	427,500
Hogs - 1971	245,000	.40 P.U.	.30 P.U.	98,000	73,500
All Cattle - 1972	3,165,000	.90 P.U.	.65 P.U.	2,848,500	2,057,250
		[2]3,037,375 Average		[1]3,516,500	[1]2,558,250
		Ratio - Gasoline 75%	Diesel 25%	2,278,031	759,344

[1] This figure reflects the total amount of each fuel used if it were used exclusively.

[2] This figure is the average and total gallons of both fuels used for livestock production.

ESTIMATES OF FUEL BURNED FOR CROP AND LIVESTOCK PRODUCTION UNDER AVERAGE CONDITIONS

8/74 - M. O. Mortensen

Montana

CROP	SEEDED 1973 ACRES	FUEL USED PER ACRE GASOLINE (GALLONS)	FUEL USED PER ACRE DIESEL (GALLONS)	TOTAL FUEL USED PER CROP GASOLINE (GALLONS)	TOTAL FUEL USED PER CROP DIESEL (GALLONS)
Corn Conventional Methods Whole Plant Silage	93,000 A.	12.0 P.A. 6.	8.65 P.A. 17.28	1,104,000	795,800
Oats	510,000 A.	6.5 P.A.	4.7 P.A.	3,315,000	2,397,000
Barley	2,100,000 A.	6.5 P.A.	4.7 P.A.	13,650,000	9,870,000
Flaxseed	15,000 A.	6.5 P.A.	4.7 P.A.	97,500	70,500
Sugarbeets (Corn Silage Info)	45,900 A.	23.7 12.0 P.A. 20.6	21.54 8.65 P.A. 18.9	550,800	397,035
Dry Beans (Soy Info)	9,000 A.	9.0 P.A.	6.5 P.A.	81,000	58,500
Potatoes	7,000 A.	9.0 P.A.	6.5 P.A.	63,000	45,500
All Hay Native & Others	2,450,000 A.	12.0 P.A.	8.65 P.A.	29,400,000	21,192,500
Spring Wheat	2,035,000 A.	6.5 P.A.	4.7 P.A.	13,227,500	9,564,500
Winter Wheat (Seeded)	2,200,000 A.	6.5 P.A.	4.7 P.A.	14,300,000	10,340,000
		[2]65,260,067 Average		[1]75,788,800	[1]54,731,335
		Gasoline-Diesel			
		Ratio - 50% - 50%		32,630,033	32,630,033
		Ratio - 60% - 40%		39,156,040	26,104,003

[1] This figure reflects the total amount of each fuel used if it were used exclusively.

[2] This figure is the average and total gallons of both fuels used for crop production.

Attachment 4
information from John Clark,
Research Division, Mont.
Department of Revenue

FISCAL YEAR	TOTAL GALLONS FOR WHICH REFUNDS WERE MADE
1970-71	31,035,031
1971-72	27,385,428 *
1972-73	34,784,141
1973-74	32,472,828
1974-75	31,503,864 ‡

* A SIGNIFICANT NUMBER OF CLAIMS FOR FISCAL 1971-72 WERE NOT PROCESSED UNTIL THE NEXT FISCAL YEAR (1972-73)

‡ ABOUT 92% OF THIS TOTAL REPRESENTS AGRICULTURAL USE (DURING 1974-75 THERE WERE APPROXIMATELY 12000 CLAIMANTS)

just gasoline

Attachment 5

February 27, 1975

MEMO

On 2-25-75 I contacted Mr. Dick Meyers from Montana State Agriculture Department concerning volumes of gasoline used by agriculture in 1972, 1973 and 1974.

Mr. Meyers returned the following information based on the figures of an average of 13,000 reporting farms:

1. In 1972 there were approximately 25,500 farms in Montana. Based on the above average, their direct gasoline use was 28,856,000 gallons.
2. In 1973 there were approximately 25,100 farms in Montana. Based on the above average, their direct gasoline use was 26,544,000 gallons.
3. In 1974 there were approximately 24,900 farms in Montana. Based on the above average, their direct gasoline useage was 34,502,000 gallons.
4. In 1975, there are 24,600 farms in Montana.

Sincerely,

John C. Braunbeck
A. F. A. O.

JCB:mt